CHINA'S PROSPECTING TECHNOLOGY AND FACILITIES

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Advances in Aerial Surveying

It is well known that China is a country of vast size, varied geography and topography, and a complex variety of minerals and geological conditions. Since the liberation, geological investigation has continued on a large scale, and prospecting methods and techniques based on geophysics and geochemistry have now been generally adopted. Systematic aerial magnetic measurements have been carried out over the entire country in order to obtain basic geophysical data.

Significant aerial prospecting activity began in 1953 and already measurements have been made of five million square kilometers, or almost half the area of China. Although China was reputedly poor in petroleum, with the discovery of the Ta-ch'ing oil fields through aerial prospecting methods, China became self-sufficient at one swoop. Since aerial prospecting is done with magnetic measurements, radioactivity measurements and other geophysical exploration methods from aircraft, underground ores are prospected for with very sensitive measuring instruments. Compared to ground prospecting, aerial prospecting has many advantages, and it goes without saying that aerial prospecting has demonstrated great effectiveness in mountainous and desert areas where ground prospecting is bent with difficulties. Considering the small expense, the efficiency of aerial prospecting is very high, and requires little time. That is because it is possible to ascertain easily the ore distribution over a broad area and provide an over-all basis for planned exploitation. The amount of measurement work done in one year by one aircraft is equivalent to the total of that of thirty ground measurement teams.

After the beginning of the Second Five-Year Plan in 1958, because of the rise in national demands on the ore resources, China's aerial prospecting strength has been expanded. On the evidence of several years' records, the technological level has also rise quite a bit. In order to rapidly discover underground ores, aerial measurement personnel are divided in two groups, one in the air and one on the ground. When the expected situation is discovered by aerial measurements, it is immediately investigated by ground personnel, and if the results are favorable, geological studies are made. Under this method, it often takes no more than a few months from the beginning of aerial measurements until boring, and in the case of one large iron ore deposit, it is said to have taken no more than two months from the start of aerial measurement to the ascertaining of its value.

The greatest problem in aerial exploration is the guiding of the aircraft's flight, but even here remarkable progress has been made in these few years. At first, the method of setting up markers on the ground was used. This meant laying out a straight line on the ground by theodolite and putting up a large flag marker every kilometer. Since measurements are fast in aerial exploration, it was necessary for the people and cars which set up the signals to do so before the flight, which meant a loss of manpower and time. It is obvious that this method would not adequately answer the needs as aerial exploration came to be used more and more. For several years radio-fix and derivational apparatus were tested and are now in actual use. The machine could find its own position accurately based on radio signals received over any area and adjust the course. By using this new technique, measurement results and geographical location were more accurately related. The laborious work of the ground crews was eliminated, and more rapid measurement was made possible.

Construction of Latest Magnetometer

With the development of geological research activity, a more accurate measuring device was required for prospecting--particularly for aerial magnetic exploration--and China had great success here also. The young professors of Changchun Geogogical Science Academy's Physical Prospecting Devices Laboratory had repeated successes from 1958 to the present with aerial core-driven magnetometers, semi-conducting core-driven magnetometers, and pump magnetometers in research and tests. The first two magnetometers are already in production, and the fact that these devices have appeared is very noteworthy in that it puts an end to the backward situation in China, where, up to now, high-accuracy magnetometers were imported from abroad.

The professors and students of the Changchun Academy of Geology, Department of Physical Prospecting discovered that several area of China are magnetically weak and cannot be measured without a high-accuracy magnetometer, and they began study and trial manufacture of three types of magnetometers in 1958. At that time aerial saturation-type magnetometers imported from abroad were used in China, and the supply of these from the Soviet Union was cut off when relations worsened.

Many difficulties were encountered in trial manufacturer but in the spirit of working out one's problems by one's own power, these were overcome. In the study of the aerial core-driven magnetometer, the recording device, which is the point of this measuring instrument, consists of either conduction-typewriter types or punched-card types in those used abroad, but as many deficiencies are found in the conduction-typewriter type, an electric numeral substitution recorder was designed. The problem of automation was resolved, and after a year's efforts, success was obtained with the core-driven magnetometer and the semi-conducor core-driven magnetometer.

Research and trial manufacture of the pump magnetometer was an even more important task. These measurement devices are made in several countries abroad, but technical data were unavailable. They had had no contact with pump technology. On the detection head of this meter there are four large points, three of which were designed and manufactured by the Chinese themselves. By dint of great effort and study and after more than one thousand experiments in fifty odd days, they finally succeeded in making the fourth part--an infra-red polarizer. This trial manufacture and research were successfully completed with four months of the first plan due to their efforts.

The Physical Prospecting Instruments Training and Research Committee obtained a great deal of assistance from everywhere in the study and trial manufacture of this meter. More than forty research organizations, schools and factories worked for the birth of this meter. Within the school the abilities of a large variety of professors and student teams were called upon.

Approximately forty professors and students participated in research and designing of the aerial core-driven magnetometer, and based on the requirements for the parts and the general design of the meter, various methods were sought out. After the successful completion of the general design, the various concrete problems in parts and parts manufacturing were gradually resolved by means of mass discussions. In the design of the auto recording device, seven types were proposed after an analysis of the recording devices of physical prospecting instruments and medical instruments. When comparative studies were made on these seven plans, there were a number of developments and the electric recording method emerged, signifying a breakthrough in technological obstacles in meter design.

In the course of the research and testing, the Physical Prospecting Instruments Training and Research Committee fostered the development of men of talent. At first there was a scientific group composed of five young professors in the Committee which was weak, with an average age of less than twenty-four, but now the number of professors on the Committee is sixteen, all of whom have attained a command of UHF, high vacuum, infrared and pump techniques and acquired quite complete experience in the construction of magnetometers.

Research on Prospecting and Geological Facilities

Above is an example of the development of the latest measuring instruments for use in prospecting, but the latest report of facilities for prospecting and geological investigation must include the double-beam autorecording infrared spectrophotometer successfully tested recently by the Peking Scientific Instrument Factory. This infrared spectrophotometer is an extremely high precision meter applying the principles of optics, precision mechanics, and electronic engineering, and which uses the infrared absorptivity of the material to determine the composition and nature of a substance, measure its purity, and make a qualitative and quantitative analysis of its elements and compounds. This method of analysis is very fast compared to usual chemical analysis methods, is very sensitive, and has the strong point of allowing analysis to be conducted when the sample is very small and without breaking the external form of the sample. Thus it has broad applications in industrial and scientific research fields--in petroleum, synthetic rubber and textiles, prospecting, pharmacentics, etc. The Peking Scientific Instrument Factory, under poor technical conditions and with rough facilities, carried on the success of the scientific research of related units of the Academy of Sciences of China, and with the assistance of more than ten factories it went on to manufacture special facilities and instruments, and subsequently suceeded in trial-manufacture of a spectrophotometer in only a little over four months' time.

Furthermore, the Nanking Earth Measurement Instrument Factory is mass-producing earth measuring instruments, which are important and necessary not only in geological exploration, but also in soil improvement, water-conservancy construction, etc. At present, the number of earth measurement devices supplied by the Nanking Earth Measurement Instruments Factory number more than forty, and these can produce reliable data on soil, temperature, humidity, viscosity penetration and saturation power, etc. The soil hardness meter recently successfully tested by this factory is simple in construction, small in size and only 6.3 kg in total weight. This meter is capable of automatic recording and is designed for multiple point recording. When using it, by turning the meter handle, a metal drill is put 200 mm into the earth and the data on soil hardness are automatically recorded on recording paper. Eighty hardness coefficients can be recorded before changing the paper.

Studies on the Geological Age of Granite in South China

Even on the basis of the above fragmentary reports, it can be seen that in the decade or so since the liberation prospecting technalogy has made great strides forward in China. In fact, great discoveries have been made which provide now knowledge and stimulate the advance of prospecting activity. The most characteristic discoveries have been made in research by professors and students of Nanking University's Department of Granite Geology on the geological period of granite in the South China area.

Granite is widely distributed in South China area, particularly in the provinces of the Southeast. It occupies roughly one quarter of the total area. Over the past forty years this granite has generally come to be regarded as having been formed in the geological age called the Yen-shan period, more than one hundred million years ago. With the large-scale advances of measurement and general geological investigations since the liberation, the following problems have been frequently encountered. In some granite there is ore and in some granite, there is none; in some granite there is one kind of ore and in other granite, there is another kind of ore. If all the granite was formed in the same period, why are these differences produced?

The professors and students of the Department of Geology of Nanking University did not blindly accept the conclusions of their predecessors, but on a basis of respect for the results of their predecessors' studies they began field investigations and initiated research on the problem of why theory and evidence were somewhat contradictory. In the fall of 1957 Professor Hsu K'o-ch'in (1776 0344 0530) Department of Geology led a number of students in discovering granite from the Caledonian period, approximately 200 million years earlier than the Yen-shan period, with exact proof from geological boring in southern Kiangsi Province. They attached very great significance to this discovery and they decided to take up the topic very seriously and continue their research in depth. After 1958 the number of individuals participating in the research was more than eighty professors from six training and research committees and more than one hundred advanced students. They made comprehensive studies of the granite of the South China area from the fields of local geology, structural geology, petrology, mineralogy, geochemistry, ore deposits and isotope geology.

Over a period of eight years they have made geological measurements of an area of approximately 50,000 square kilometers where granite is concentrated, and have observed more than two hundred granite bodies, studied them, and collected several tens of tons of granite and ore samples. In the laboratory they have performed a large number of analyses, evaluations and experiments. Chromatography was carried out more than eight thousand times for a large number of the granite samples collected, and more than six thousand thin sections of granite were evaluated. Furthermore, for a large number of rock specimens, various precise analysis and determination of absolute age. From a large quantity of scientific data a series of important principles were found.

The professors and students arrived at the following conclusions through repeated study and investigation of evidence over a period of eight years. The granite of the South China region is not of a single age but belongs to four geological periods. These four periods are:

Hsueh-teng	ca.	600-800 million years ago
Caledonian	ca.	380-480 million years ago
Indonesian	ca.	180-230 million years ago
Yen-shan		90-230 million years ago

It is also clear that within the same period some granite is earlier and some later.

Rough relationships were found between the granite of each era and the ore deposits therein. For example, gold ore is associated primarily with the hsueh-feng and Caledonian eras, and tin is associated chiefly with the Indonesian and Yen-shan periods, while tungsten is related with granite of the Yen-shan era, some particularly with the late Yen-shan period.

Furthermore, referring to material related to the era of production, the regularity of geographical distribution of granite in different periods is related with local geography. According to this principle, it became possible to predict what types of ore should be found in any given locality, and comparatively effective prospecting was carried out in certain areas in connection with other geological conditions. Thus a great deal of the hit-and-miss factor in mining exploration has been eliminated.

Furthermore, based on the characteristics of history and local geology of granite formation in the south China area, a new concept of the nature of the land structure of the South China area emerged, and elementary investigation has been carried out on theoretical problems of the relationship of geological structure and the formation of different types of ores granites. This is thought to be something which will provide still more advantages in the development of geological theory and guidance of prospecting activity.

Photo Captions

1. Investigation Team from the Soil Research Institute of the Chinese ACAD of Sciences making a study of loess hills which runs through the southern part of Chekiang Province. (CIA 1147634)

2. Electronic automatic voltmeter produced by the Shanghai Geological Instrument Factory. Measures differences in potential in geological studies in the DC meters. (CIA 1147635)

3. Stone density meter, produced at Peking Geological Instrument Factory. Measures the humidity and density of rocks which do not dissolve in water. Used in geological research and mining laboratories. (CIA 1147636)

4. (Above) Chinese-made, BaT:C_3 crystalloid oscillation converter. A device for changing oscillatory movement into electric energy, used for sea-floor earthquakes and prospecting. (CIA 1147638)

(Below) Chinese-made earthquake oscillation converter. Used in earthquakes and prospecting by means of radioactivity and refraction, it converts movements of the earth's surface into electricity. (CIA 1147639)

5. Professors and students of the Department of Geology, Nanking University, have divided the formation of granite in the South China area into four periods and clarified the relationships between the granite of each period and the minerals in it. In the past forty years Chinese geologists had thought that the granite of this area was formed one hundred and eighty million to ninty million years ago in the Yen-shan period, and the discovery at the university is recognized to have

great significance for prospecting construction. The photo shows members of the Department of Geology at Nanking University who are studying granite. (CIA 1147640)

6. Samples of South China granite shown to belong to four geological ages. The two on the extreme left are of the Hsueh-feng period (600-800 million years ago), the second two from the left are from the Caledonian period (380-480 million years ago), the third two from the left are of the Indonesian period (180-230 million years ago); and the two on the extreme right are of the Yen-shan period (90-180 million years ago). (CIA 1147641)

7. Measuring the absolute age of granite at Nanking University's Department of Geology. (CIA 1147641)

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PRODUCTION OF PRECISION SCALES IN CHINA

One-ten millionth of one Gram Super Precision Scales

Recently China has been achieving considerable success in producing precision scales, which are thus far manufactured in only a few countries of the world. The most noteworthy one among them is the vacuum-quartz small-quantity heat scales, whose production, in small numbers, was begun this year at the Shenyang City Glass Laboratory. It is a super-precision balance which has a minimum sensitivity of one-ten millionth of one gram. Test production of these scales was achieved by the Metal Laboratory of the Chinese Academy of Science, and the Shenyang City Glass began their manufacture.

In a scientific laboratory test, the variation of mass must be observed often under the condition of vacuum and/or of high heat. Such variation is extremely small and is difficult to measure without the help of a highly elaborate balance. The precision small-quantity scales hitherto produced by China had had a minimum sensitivity of one-millionth of one gram. Although this balance was so elaborate as to weigh even a piece of cotton fiber or an ink spot on a piece of paper, it was unable to meet necessities adequately.

The smallest weight used for the newly-produced quartz small-quantity heat balance, which has a minimum sensitivity of one-ten millionth of one gram, weighs 0.01 mg. and is finer than human down; and during the operation it could be blown away unless the operator stops his breath. This balance is composed of three parts, namely, vacuum, heat, and balance. The parts of the balance are set in the vacuum system, are resistent to high temperature and corrosion, and are made of quartz glass which has a very small factor of expansion. The balance can measure metal or high temperature test material which is heated to 1,000 degrees centigrade, and the sensitivity and accuracy of the balance are not at all affected even by carbondioxide or steam.

One-millionth of one Gram Precision Scales Produced by the Peking Optical Instrument Manufactory

Although the above points out an epochmaking achievement in the recent meter industry in China, the precision small-quantity scales with minimum sensitivity of one-millionth of one gram are produced at the Peking Optical Instrument Manufactory and the Shanghai Scales Manufactory.

According to the Jenmin Chipao of January 24, 1966, the Peking Optical Instrument Manufactory succeeded prior to this spring (January of the lunar calendar) [sic] in the test production of high-precision balance which has a maximum weighing capacity of 20 grams. According to the report, the production of this high-precision balance was said to have been possible only after the ideological struggle of whether or not to tackle the heavy burden of revolution and achieve a high technological standard. Half a year prior to this, the National Meter Bureau requested this factory to present a test product of a super high-precision scales. Then there were a variety of opinions: some supported the request; some were skeptical about its success; others argued that such a high-precision balance was produced only in a few countries of the world and that their factory was not equipped with the necessary means to produce such scales; and still others maintained that the precision scales hitherto produced in China reached barely the third-class standard, and a high technological standard should be achieved step by step; hence second- and the first-class test products should precede the super-class test product. However, it is said that meanwhile a movement to study the thought of Mao Tse-tung was launched and the spirit to overcome difficulties to produce this super-class precision balance was generated. Thus the key engineers began to review the up-to-date experiences of the test production of precision small-quantity scales; and by making the best use of the valuable results of experiences, they finally succeeded in designing a blueprint for the high-precision balance. The craftsmen are reported to have succeeded after a series of trials in the test production of all the 400-odd parts needed to make a high-precision balance in approximately half a year.

One-millionth of one Gram Scales Produced by the Shanghai Scales Manufactory

According to a telegram dispatched by the New China [News] Agency from Shanghai on October 17, 1965, the Shanghai Scales Manufactory also succeeded in producing a precision small-quantity balance which has a minimum sensitivity of one-millionth of one gram and a maximum weighing capacity of 2 grams.

The weight used for this precision small-quantity scales is smaller than a grain of white confectioners' sugar crystal and can be blown away even by a single careless breath. The balance has a very keen sensitivity, and when it is approached by a hand, it is able to sense even so slight a variation of weight as is caused by the body temperature of man. Consequently, the balance is kept in a controlled-temperature room with a separator attached outside. Both the materials to be weighed and the weights to be used are carried in through two "windows" by the revolving pan of the scales. The windows are always closed and the switch is controlled completely from the outside. This precision balance is used by a national meter certification authority for the measurement of standard weight; apart from this, it is necessary for the laboratories and test rooms of scientific research organizations, universities, and professional schools when they measure the mass of a matter.

The Shanghai Scales Manufactory which produced this balance also manufactured in 1960 a small-quantity balance which was capable of weighing one-two hundred thousandth of one gram. Subsequently, in early 1963, it received a mission for test production of one-millionth of one gram precision small-quantity balance and succeeded in its test production in late 1964. According to the above-mentioned source, in foreign countries, copper and aluminium are used for the beam of a precision balance, but the engineers of the factory have made the beam using a more ideal material. This material is said to be relatively light and to have a high degree of mechanical proof, and the effect of heat upon this material to be relatively small. The manufacture has a margin of error of about one graduation (one-millionth of one gram), and this index is a considerably advanced one even by international standards.

In the course of the test production, both the engineers and the workers made great efforts to overcome the difficulties associated with revisional test. The test, of course, must be conducted in a controlled-temperature room, whose temperature must be fairly high. Since there was no temperature-control facility in the factory, they built a simple such facility through their own efforts. As a result of their experiments, they also discovered a comprehensive method of testing a precision small-quantity scales, and thus prepared the necessary condition for the formal production of this manufacture henceforth.

Shanghai Linung Scales Manufactory and Shenyang Teko Scales Manufactory

Among other factories which have been promoting the production of high precision scales are Shanghai Linung Scales Manufactory and Shenyang Teko Scales Manufactory.

Early last year the Shanghai Linung Scales Manufactory manufactured three kinds of high precision standard scales with a large weighing capacity, each having a load capacity of 1 kg, 5 kg, and 20 kg. These standard scales are the precision gauges necessary for the mining industry, scientific research organizations, and the laboratories of universities and professional schools; their respective graduation units are 0.5 mg, 2.5 mg, and 10 mg; and each of them has the precision of one-two millionth of its full scale. For example, when a 1 kg material is weighed by the 1 kg scales, even the additional weight of 1.6 cm-long hair is immediately indicated on the scales.

It is the Teko Scales Manufactory of the Shenyang City which succeeded in producing China's first second-class 5 kg balance and first-class 1 kg balance, having been enlightened by Shanghai Linung Scales Manufactory which is a sister factory of the former. Although the Shenyang factory is one of the factories in China which started to produce scales relatively early, it could, until 1965, produce only fifth-class scales of comparatively low accuracy. Hence early last year, on the occasion of reviewing the performance of the factory, various questions were raised and answers were sought on its inability to produce high-precision scales above the fourth class.

Traditionally, the scales produced by this factory were an imitation of foreign products; and because of their complicated structure, much material was wasted and not only was the cost of production high, but also the quality of the products was relatively inferior. Within the last few years, the factory carried out a number of improvements, yet was unable to achieve a significant breakthrough. Some people thought that it was no mistake to imitate foreigners because the latter had several decades of experience in scales production, whereas they themselves were still young, inexperienced, and lacked in expertise and suitable facilities. Against such spiritual state, however, the factory branch of the Chinese Communist Party organized the employees of the factory so that they should learn the relevant writings of Chairman Mao; and thus by liberating their thoughts and elevating their recognition, it succeeded in producing, with a single leap a fourth-class 5 kg balance. Then some leading members of its management who were satisfied at this result, took a strong pride in their achievement.

Before long, however, a group of the "union of the three" -- the leading members of management headed by the vice chief of the factory, Chang Chung-Fu, technicians, and laborers -- visited Shanghai Linung Scales Manufactory, which had been a long-time competitor of the Shenyang Teko Scales Manufactory, for an observational study. They were very surprised at learning that the Shanghai factory was producing third-class 5 kg scales. Upon returning to their factory, they rallied all their vigor in order to produce second and first-class scales by leaping over the barriers of producing third-class scales, and commenced the engineering and test-production activities for second-class 5 kg and first-class 1 kg scales, organizing a small team of the "union of the three" for the test production of new manufactures. Owing to the herioc ambition of the employees to overtake and bypass the advanced plants and to their clear understanding of the significance of catching up at a bound even the seemingly insolvable problems confronted in the course of engineering and test production were smoothly solved and the two kinds of high-precision scales, which until then China had never been able to produce, and which were urgently needed for scientific research organizations and the department of weights and measures, were produced in only three months.

A precision small-quantity balance manufactured by the Shanghai Scales Instrument Manufactory with a minimum sensitivity of one-millionth of a gram and a maximum load capacity of two grams.

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Precision balance, Model WT2B manufactured by the Peking Optical Instrument Manufactory. It has a maximum scale capacity of 20 grams, and a minimum reading value of 0.01 mg.

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Precision balance, Model GT2A produced by the Peking Optical Instrument Manufactory. It has a maximum scale load of 200 g. and a minimum reading value of 0.1 mg.